Docket No.: PII-28302/04

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
William W. King

Application No.: 10/649,025 | Confirmation No.: 5132

Filed: August 27, 2003 | Art Unit: 1794

For: CORROSION-RESISTANT COATING COMPOSITION FOR STEEL, A COATED STEEL PRODUCT, AND A STEEL COATING PROCESS | Examiner: J. J. Zimmerman

AMENDED APPEAL BRIEF

MS Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Notification of Non-Complaint Appeal Brief mailed on December 12, 2007, Applicant submits the following Amended Appeal Brief. The amendment to Section III is believed to the place the Appeal Brief into compliance with 37 CFR 41.37. If there are any questions, comments, etc., please contact the attorney listed below.

I. REAL PARTY IN INTEREST

The real party in interest in this appeal is the inventor, William W. King.

II. RELATED APPEALS AND INTERFERENCES

Appellant is aware of no appeals or interferences pending or otherwise related to the present appeal.

III. STATUS OF CLAIMS

Claims 1-7, 11-13 and 23-30 have been canceled. Claims 8-10, 14-22 and 31-41 are the pending claims for the application.

All of the pending claims (8-10, 14-22, 31-41) stand finally rejected.

No claims are allowed. All of the pending claims (8-10, 14-22, 31-41) are appealed claims.

IV. STATUS OF AMENDMENTS

An amendment was presented prior to final rejection and was entered. Thus all of the amendments filed by Applicant have been entered.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The present invention of independent claim 8 relates to a corrosion-resistant steel (page 6, line 14) comprising a mild steel substrate miscible with molten zinc (Figure 2A) with an adjacent iron-aluminum intermetallic alloy layer (page 7, line 1) having a top surface and a bottom surface (Figure 2D), the iron-aluminum intermetallic layer having a thickness of greater than 1 micron and less than 5 microns (page 9, line 15). The present invention of independent claim 31 narrows the invention of independent claim 8 by requiring a zinc layer having a lower surface in contact with the top surface of the iron-aluminum intermetallic layer (Figures 2A and 2C).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 9-10, 14-22, 32-33 and 39-41 stand rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement. Claims 9 and 32 were amended such that support was provided by the specification in order to remove this rejection, and although the proposed amendment was entered by the Examiner, no response with regards to

this §112 rejection was received in the Advisory Action mailed on October 30, 2007. Given that the claims were amended to comply with the written description requirement, Applicant assumes this rejection was withdrawn, or will be withdrawn, and only the 35 U.S.C. §103 rejections are discussed below.

All of the pending claims (8-10, 14-22, 31-41) stand finally rejected under 35 U.S.C. §103(a) because the claimed invention has been deemed obvious over the prior art. Claims 8-10, 14-16, 20-21, 31-35 and 39-41 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Okumura (JP 06-299312), hereafter referred to as Okumura. Claims 8-10, 14-22 and 31-41 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Okumura in view of Applicant's disclosure of the prior art.

VII. ARGUMENT

A. The Examiner's Position.

The Examiner has based the rejection of claims 8-10, 14-16, 20-21, 31-35 and 39-41 under 35 U.S.C. §103(a) on Okumura as the principal reference. Okumura is cited as teaching a steel having an iron-aluminide intermetallic alloy layer with a thickness of about 1 micron or less, but with comparative examples of up to 5 microns and a bath aluminum content of 20-80 wt% (with reference citations to Okumura found in Paper No. 20070831, section 6, 1st paragraph). The ability of the steel substrate to be miscible with molten zinc is stated to be inherent to the composition of the article and an upper zinc layer is formed on the steel.

The Examiner states that although Okumura claims an iron-aluminide intermetallic alloy layer thickness of 1 micron or less and Appellant claims a thickness of greater than 1 micron, the thicknesses of 1 micron and greater than 1 micron are so close that, *unless shown otherwise*, one

of ordinary skill in the art would not expect there to be a patentable distinction between the properties of the two thicknesses (emphasis added, Paper No. 20070831, section 6, 1st paragraph). The Examiner further states that in any event, Okumura clearly shows comparative examples having intermetallic layers of 1.5 microns, 2 microns, 3 microns and 5 microns (Paper No. 08312007, section 6, 1st paragraph).

The Examiner has based the rejection of claims 8-10, 14-22 and 31-41 under 35 U.S.C. §103(a) on Okumura in view of Appellant's disclosure of the prior art. With regard to independent claims 8 and 31, the Examiner uses the same reasoning for the rejection of the claims 8-10, 14-16, 20-21, 31-35 and 39-41 as described above.

B. Appellant's Position as to the Patentability of All the Pending Claims.

The United States Patent and Trademark Office (USPTO) has provided "guidelines for determining obviousness under 35 U.S.C. 103 in view of the Supreme Court decision in *KSR International Co. v. Teleflex, Inc.* (see e.g. Federal Register, Vol. 72, No. 195, 57526-35). Within these guidelines the USPTO has set forth rationales to support rejections under 35 U.S.C. §103 after the *Graham* factual inquires are resolved (Federal Register, Vol. 72, No. 195, 57528-34). These rationales are:

> (A) Combining prior art elements according to known methods to yield *predictable results*;
>
> (B) Simple substitution of one known element for another to obtain *predictable res*ults;
>
> (C) Use of known technique to improve similar devices (methods, or products) in the same way;
>
> (D) Applying a known technique to a known device (method, or product) ready for improvement to yield *predictable res*ults;
>
> (E) "Obvious to try" - choosing from a finite number of identified,

> predictable solutions, with a *reasonable expectation of success*;
>
> (F) Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been *predictable* to one of ordinary skill in the art;
>
> (G) Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

(emphasis added, Federal Register, Vol. 72, No. 195, 57529). It is important to note that these rationales are to be approached within the framework that "[t]he key to supporting any rejection under 35 U.S.C. 103 is the clear articulation of the reasons(s) why the claimed invention would have been obvious" (Federal Register, Vol. 72, No. 195, 57528).

With the above approach in mind, the Examiner has stated clearly that the §103(a) rejections of independent claims 8 and 31 are based on the reason that "the thicknesses of 1 micron and "greater than 1 micron" are so close that, *unless shown otherwise*, one of ordinary skill in the art would not expect there to be a patentable distinction between the properties of the two thicknesses (emphasis added, Paper No. 20070831, section 6, 1st paragraph). Appellant asserts, and the Examiner has rejected, that Okumura clearly "shows otherwise" as to why one skilled in the art *would* expect there to be a patentable distinction between the properties of the two thicknesses. In fact, the comparative examples cited by the Examiner provide the evidence that: (1) Okumura teaches away from the claimed invention; (2) the claimed invention provides unpredictable results (see rationales A, B, D and F above); and (3) was achieved with no reasonable expectation of success (see rationale E above). In addition, Okumura's teachings also prevent rationales C and G from providing reasoning for obviousness since Okumura teaches

that it is "impossible" to have a 1 micron thick iron-aluminum intermetallic layer without "remarkably [degrading]" the properties of the plated steel.

In summary, the claimed invention discloses a mild steel substrate that is miscible with molten zinc, the substrate having an adjacent iron-aluminum intermetallic alloy layer with a thickness of greater than 1 micron and less than 5 microns. The iron-aluminum intermetallic alloy layer inhibits steel electrochemical oxidation by gaseous oxidants (original application, page 7, line 3). The outstanding rejections fail to provide a teaching commensurate with the appealed claims and the aspects of unexpected results, unique species, teaching away, and secondary considerations are discussed in more detail below.

Instant Invention Contrary to Accepted Wisdom of the Relevant Art:

The prior art taken as a whole teaches that an intermetallic layer should not exceed a thickness of 1 micron. The totality of the prior art must be considered, and proceeding contrary to accepted wisdom in the art is evidence of nonobviousness. *In re Hedges*, 783 F.2d 1038, 228 USPQ 685 (Fed. Cir. 1986) (Applicant's claimed process for sulfonating diphenyl sulfone at a temperature above 127°C was contrary to accepted wisdom because the prior art as a whole suggested using lower temperatures for optimum results as evidenced by charring, decomposition, or reduced yields at higher temperatures.) Similarly, the prior art in creating intermetallic layers on steel for corrosion resistance teaches that the thickness of the intermetallic layer should be as thin as possible. For example, Sippola (US Patent 4,971,842) teaches that when forming an intermetallic layer of iron-zinc when coating steel with zinc "[i]n order to achieve good formability of the zinc coating, the intermetallic layer should be as thin as possible." Further, Okumura teaches that "the workability of plating steel materials is degraded remarkably" by an intermetallic layer greater then 1 micron. [0012] (emphasis added). Thus,

both Okumura and the prior knowledge in the art recognized that an intermetallic layer greater than 1 micron made the steel unworkable. As such, the use of an intermetallic layer between 1 and 5 microns in thickness is contrary to the accepted wisdom in the prior art dictates that the instant invention is nonobvious.

Furthermore, "[k]nown disadvantages in old devices which would naturally discourage search for new inventions may be taken into account in determining obviousness." *United States v. Adams*, 383 U.S. 39, 52, 148 USPQ 479, 484 (1966). Okumura teaches that "according to this invention, it is necessary to set to 1 micrometer or less thickness of the intermetallic-compound layer." [0009] Okumura reasons that the greatest thickness of the iron-aluminum layer is 1 micron because steel manufactured with an intermetallic layer is "also hard, it is weak and a processing student will deteriorate if the thickness exceeds 1 micrometer." [0009] Finally, when the "growth of a Fe-aluminum intermetallic-compound layer becomes excessive, it becomes impossible to carry out 1 micrometer of the thickness, and both the workability of plating steel materials is degraded remarkably in this way." [0012] (emphasis added) Thus, the known disadvantages of increased processing section crack initiation [Table 2] when the intermetallic layer is greater than 1 micron naturally discourage the search for new inventions with an intermetallic layer greater than 1 micron. This provides further evidence of nonobviousness of the instant invention.

Unexpected Results:

Okumura is cited as teaching an iron-aluminide intermetallic alloy layer with a thickness of about 1 micron or less. (Paper No. 20070325, p. 3.) However, Okumura does not teach an intermetallic layer of about 1 micron or less, rather Okumura teaches an intermetallic layer at one micron or less. ("it becomes impossible to carry out 1 micrometer of the thickness." [0012] of

Okumura; "according to this invention, it is necessary to set to 1 micrometer or less thickness of the intermetallic-compound layer." [0009]; "base materials from Fe-aluminum with a thickness of 1 micrometer or less." [0007]) Thus, Okumura does not teach a range of about 1 micron, but at one micron and specifically places an upper limit on the range of iron-aluminum thickness at 1 micron. Okumura reasons that the greatest thickness of the iron-aluminum layer is 1 micron because steel manufactured with an intermetallic layer is "also hard, it is weak and a processing student will deteriorate if the thickness exceeds 1 micrometer." [0009] Further, when the "growth of a Fe-aluminum intermetallic-compound layer becomes excessive, it becomes impossible to carry out 1 micrometer of the thickness, and both the workability of plating steel materials is degraded remarkably in this way." [0012] (emphasis added). Appellant amendment made of record on 9 March 2007 includes the full translation of the above cited paragraphs of Okumura.

The thickness of the claimed intermetallic layer of claims 8 and 31 is "greater than 1 micron and less than 5 microns" and is essential to its function as an anti-corrosive that has an extended serviceable lifetime. Applicants can rebut a *prima facie* case of obviousness based on overlapping ranges by showing the criticality of the claimed range. MPEP 2144.05. The criticality of an intermetallic layer thickness between 1 and 5 microns was alluded to by the prior art disclosed in the specification.

> There have been countless prior art coating and processes intended to protect steel from electrochemical oxidation. Unfortunately, all of these methods have invariably been effective for a period of time less than the useful life of the steel-containing article thereby resulting in the need for regular maintenance checks, reapplication of coatings, and often the replacement of the steel article.

(paragraph bridging pgs 1 and 2.) Further, "in complex piping or engineering structures, evaluation, recoating and replacing steel regularly exceeds the initial construction cost over the lifetime." *Id.* Thus, the prior art steel, even that with an intermetallic layer at 1 micron, is insufficient in the art of steel construction. An intermetallic layer between 1 and 5 microns is critical to the instant invention and represents a compromise between the thin layer of Okumura that provides inadequate protection and thicker films that provide distinct operational limitations. As such, claim recitation as to this thickness range should be accorded patentable weight. This additional thickness provides corrosion resistance unattainable by the prior art where "an intermetallic surface alloy of sufficient thickness . . . remains a challenge. (p. 3, lines 17-18.) Thus, the range between 1 and 5 microns, as in the instant invention, is critical to its success overcoming the *prima facie* case of obviousness.

The instant invention, further provides unexpected results by overcoming "the ductility and strength of such intermetallic alloys relative to an underlying steel substrate [and] fabrication issues" of the prior art. (p. 3, lines 19-20.) For example, Okumura teaches that "the workability of plating steel materials is degraded remarkably" by an intermetallic layer greater then 1 micron. [0012] (emphasis added). Further, Sippola (US Patent 4,971,842) teaches that when forming an intermetallic layer of iron-zinc when coating steel with zinc "[i]n order to achieve good formability of the zinc coating, the intermetallic layer should be as thin as possible. (col. 1, lines 42-44.) Thus, both Okumura and the prior knowledge in the art recognized that an intermetallic layer greater than 1 micron reduced the workability of the steel. In contrast, this failing of the prior art steel is unexpectedly not found in the instant invention. In this way, the instant invention provides steel that is capable of "extend[ing] the serviceable lifetime of steel systems exposed to gaseous oxidants." (p. 5, lines 8-9.)

> The law is replete with cases in which the difference between the claimed invention and the prior art is some range or other variable within the claims. . . . In such a situation, the applicant must show that the particular range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range.

In re Woodruff, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990). The ability of a claimed material to have an extended operational lifetime in an environment of corrosive gases relative to the state-of-the-art GALFAN® materials currently in service and the teaching away of Okumura from the claimed composition represent such an unexpected result.

Therefore, the instant specification and invention provides a range of 1 to 5 microns that is critical to generation of the increased corrosion resistance of the inventive steel product. As such, the instant invention is nonobvious over Okumura.

Unique Species:

The pending claims recite a range of iron-aluminum intermetallic alloy with a thickness "greater than 1 micron and less than 5 microns". This claimed range represents a subgenus of that is illustrated but not claimed by Okumura. If the reference's disclosed range is so broad as to encompass a very large number of possible distinct compositions, this might present a situation analogous to the obviousness of a species when the prior art broadly discloses a genus. *In re Peterson*, 315 F.3d 1325, 1330, 65 USPQ2d 1379, 1382-83 (Fed. Cir. 2003); *See also In re Baird*, 16 F.3d 380, 29 USPQ2d 1550 (Fed. Cir. 1994); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992); MPEP § 2144.08. Okumura illustrates a genus of iron-aluminum intermetallic alloys with thicknesses between 0.2 and 5 microns. However, the genus of Okumura encompasses numerous distinct compositions having unique properties. For example, steel of Okumura with an iron-aluminum intermetallic layer less than one micron possesses

excellent resistance to processing section crack initiation. [Table 2] However, the physical and chemical characteristics of Okumura steel change when the intermetallic layer is greater than 1 micron as the layer is both hard and weak such that the layer is now readily susceptible to processing section crack initiation. [Table 2] Thus, numerous species are taught by Okumura.

It is the properties and utilities that provide real world motivation for a person of ordinary skill to make species structurally similar to those in the prior art. *In re Dillon*, 919 F.2d 688, 697, (Fed. Cir. 1990) (en banc); *In re Stemniski*, 444 F.2d 581, 586, 170 USPQ 343, 348 (CCPA 1971). Conversely, lack of any known useful properties weighs against a finding of motivation to make or select a species or subgenus. *In re Albrecht*, 514 F.2d 1389, 1392, 1395-96, 185 USPQ 585, 587, 590 (CCPA 1975). The lack of known workability of the steel of Okumura with a thickness greater than 1 micron weighs against finding motivation to make or select steel with an iron-aluminum intermetallic alloy layer greater than 1 micron and less than 5 microns thick as being currently claimed. Okumura provides no real world motivation to make steel with an intermetallic layer greater than 1 micron. For example, Okumura reasons that the greatest thickness of the iron-aluminum layer is 1 micron because steel manufactured with an intermetallic layer is "also hard, it is weak and a processing student will deteriorate if the thickness exceeds 1 micrometer." [0009] Further, when the "growth of a Fe-aluminum intermetallic-compound layer becomes excessive, it becomes impossible to carry out 1 micrometer of the thickness, and both the workability of plating steel materials is degraded remarkably in this way." [0012] (emphasis added) The properties conveyed to one of skill in the art regarding the subgenus taught by Okumura between 1 and 5 microns are the reduction in workability of the substance in the prior art that is not found to be an issue with the instant invention. Okumura teaches that steel with an intermetallic alloy layer greater than 1 micron has

reduced workability characteristics decreasing the usability of the invention and the overall corrosion resistance and represents a clear teaching away from the claimed invention. The claimed steel remains workable with improved corrosion resistance. Thus, Okumura provides no real world motivation for a person having ordinary skill in the art to produce steel with an intermetallic layer greater than 1 micron and rigorously teaches away from such an effort. As such, the teaching of Okumura weighs against a finding of obviousness.

Evidence of Secondary Considerations:

The Supreme Court in *Graham v. John Deere*, 383 U.S. 1, 148 USPQ 459 (1966), stated: that "[s]uch secondary considerations as commercial success, long felt but unsolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented. As indicia of obviousness or nonobviousness, these inquires may have relevancy." Further, it is policy of the USPTO to analyze:

> [o]bjective evidence or secondary considerations such as unexpected results, commercial success, long-felt need, failure of others, copying by others, licensing, and skepticism of experts are relevant to the issue of obviousness and must be considered in every case in which they are present.

Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d 1530, 218 USPQ 871 (Fed. Cir. 1983); *Hybritech, Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 231 USPQ 81 (Fed. Cir. 1986), cert. denied, 480 U.S. 947 (1987); MPEP 2141. Arguments directed to unexpected results are stated above and are incorporated herein by reference.

The instant specification summarizes the long-felt need of the art for an improved corrosion resistant steel such as that provided by the instant invention as the prior art steel was inadequate. "The reaction of a steel surface to form an intermetallic surface alloy of sufficient thickness to provide corrosion resistance remains a challenge. Furthermore, the ductility and

strength of such intermetallic alloys relative to an underlying steel substrate often creates fabrication issues." (p. 3, lines 17-20.) "There exists a need for a more corrosion-resistant coating composition for steel . . . ." (p. 5, lines 9-10.)

The prior art of Okumura also teaches that steel with an intermetallic layer thickness greater than 1 micron is insufficient in that it shows increased processing section crack initiation. [0024; Table 2] Okumura reasons that the greatest thickness of the iron-aluminum layer is 1 micron because steel manufactured with an intermetallic layer is "also hard, it is weak and a processing student will deteriorate if the thickness exceeds 1 micrometer." [0009] Finally, when the "growth of a Fe-aluminum intermetallic-compound layer becomes excessive, it becomes impossible to carry out 1 micrometer of the thickness, and both the workability of plating steel materials is degraded remarkably in this way." [0012] (emphasis added)

Thus, the prior art and the instant specification taken as a whole highlights a long-felt need for improved corrosion resistant and workable steel such as is provided by the instant invention. Similarly, the prior work by Okumura is evidence of both failure of others and skepticism of experts in the usefulness of steel with an iron-aluminum intermetallic layer greater than 1 micron in thickness. As evidenced by the statements in Okumura cited above, the expert (Okumura) clearly identifies skepticism as to the usefulness of steel with an intermetallic layer greater than one micron due to an increase in processing section crack initiation. [0024; Table 2.]

In light of the above remarks, independent claims 9 and 31 are believed to be nonobvious over Okumura and drawn to patentable subject matter. As claims 9-10, 14-16, and 20-21 depend from claim 9, and claims 32-35, and 39-41 depend from claim 31 each incorporating all limitations from the claim from which they depend, claims 9-10, 14-16, 20-21, 32-35, and 39-41 are also believed to be nonobvious and directed to patentable subject matter.

Failure to Provide Resolution of Ordinary Skill in the Art:

Additionally, applying the examination guidelines for determining obviousness in view of the Supreme Court in *KSR International Co. v. Teleflex, Inc.* (Fed. Register Volume 72(195) 57526-57535), as part of the factual inquiry associated with determining obviousness under 35 U.S.C. §103, an obviousness rejection includes resolution of the level of ordinary skill in the art. The outstanding rejection under 35 U.S.C. 103(a) provides no such resolution of the level of ordinary skill in the art in regard to the implications of iron-aluminide layer thickness on the working properties of the resultant steel or the operational lifetime of steel as a function of iron-aluminide layer thickness as it relates to the claimed subject matter. Instead, the outstanding obviousness rejection of Paper No. 20070917 is silent as the resolution of the level of ordinary skill in the art. In this regard, the outstanding rejection fails to provide a *prima facie* case of obviousness in line with *KSR* since "Office personnel must explain why the difference(s) between the prior art and the claimed invention would have been obvious to one of ordinary skill in the art." (Fed. Register 72(195) 57528, second column). These examination guidelines caution against conclusory statements of obviousness absent articulation of why the differences are obvious. (Fed. Register 72(195) sentence spanning 57528, third column -57529, first column).

Appellant therefore submits that no *prima facie* case of obviousness is established and that this rejection of pending claims under 35 U.S.C. §103(a) is therefore improper.

C. Conclusion.

In summary, the Examiner's cited reference for the outstanding rejections includes a teaching away from the present invention and therefore results in the present invention producing unpredictable results obtained by a process which would have been known to one skilled in the

art to provide a non-reasonable expectation of success. As such, none of the rationales provided by the USPTO for determining obviousness under 35 U.S.C. §103 has been met. Accordingly, the obviousness rejection under 35 U.S.C. §103(a) with regard to all of the pending claims should be reversed.

VIII. CLAIMS

A copy of the claims involved in the present appeal is attached hereto as Appendix A. As indicated above, the claims in Appendix A include the amendments filed by Applicant on

Dated: December 28, 2007

Respectfully submitted,

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APPENDIX A

Claims Involved in the Appeal of Application Serial No. 10/649,025

8. A corrosion resistant steel comprising:

a mild steel substrate miscible with molten zinc; and

an adjacent iron-aluminum intermetallic alloy layer having a top surface and a bottom surface, said iron-aluminum intermetallic layer having a thickness of greater than 1 micron and less than 5 microns.

9. The steel of claim 8 wherein said iron-aluminum intermetallic comprises at or between 18% and 49% aluminum by weight.

10. The steel of claim 9 wherein said iron-aluminum intermetallic layer has a thickness greater than 2 microns and less than 5 microns.

14. The steel of claim 9 further comprising a zinc layer having a lower surface in contact with the top surface of said iron-aluminum intermetallic layer.

15. The steel of claim 14 wherein said zinc layer has a thickness of between 5 and 50 microns.

16. The steel of claim 15 wherein said zinc layer has a thickness of between 10 and 35 microns.

17. The steel of claim 14 further comprising a phosphating agent crystalline layer in contact with an upper surface of said zinc layer.

18. The steel of claim 17 wherein said phosphating agent crystalline comprises hexafluoro-titanium phosphate.

19. The steel of claim 17 further comprising an aluminum particulate filled cured epoxy overlayer adhering to said phosphating agent crystalline layer.

20. The steel of claim 9 wherein said iron-aluminum intermetallic layer is from 19 to 25 total weight percent aluminum.

21. The steel of claim 9 with the proviso that said iron-aluminum intermetallic layer is substantially devoid of rare earth metals.

22. The steel of claim 9 wherein said steel substrate is formed as a tube.

31. A corrosion resistant steel comprising:

a mild steel substrate miscible with molten zinc;

an adjacent iron-aluminum intermetallic alloy layer having a top surface and a bottom surface, said iron-aluminum intermetallic layer having a thickness of greater than 1 micron and less than 5 microns; and

a zinc layer having a lower surface in contact with the top surface of said iron-aluminum intermetallic layer.

32. The steel of claim 31 wherein said iron-aluminum intermetallic comprises at or between 18% and 49% aluminum by weight.

33. The steel of claim 32 wherein said iron-aluminum intermetallic layer has a thickness greater than 2 microns and less than 5 microns.

34. The steel of claim 31 wherein said zinc layer has a thickness of between 5 and 50 microns.

35. The steel of claim 31 wherein said zinc layer has a thickness of between 10 and 35 microns.

36. The steel of claim 34 further comprising a phosphating agent crystalline layer in contact with an upper surface of said zinc layer.

37. The steel of claim 36 wherein said phosphating agent crystalline comprises hexafluoro-titanium phosphate.

38. The steel of claim 36 further comprising an aluminum particulate filled cured epoxy overlayer adhering to said phosphating agent crystalline layer.

39. The steel of claim 32 wherein said iron-aluminum intermetallic layer is from 19 to 25 total weight percent aluminum.

40. The steel of claim 32 with the proviso that said iron-aluminum intermetallic layer is substantially devoid of rare earth metals.

41. The steel of claim 32 wherein said steel substrate is formed as a tube.

APPENDIX B

No evidence pursuant to §§ 1.130, 1.131, or 1.132 or entered by or relied upon by the examiner is being submitted.

APPENDIX C

No related proceedings are referenced in II. above, hence copies of decisions in related proceedings are not provided.